What is claimed is:

1. A material processing apparatus comprising:

a. a process chamber having a sample holder positioned inside the process chamber that supports material to be processed;

b. a plasma chamber comprising a portion of an outer surface of the process chamber, the plasma chamber containing a gas;

c. a transformer having a magnetic core surrounding a portion of the plasma chamber and a primary winding; and

d. a solid state AC switching power supply comprising one or more switching semiconductor devices coupled to a voltage supply and having an output coupled to the primary winding,

the solid state AC switching power supply driving an AC current in the primary winding, the current inducing an AC potential inside the plasma chamber that directly forms a toroidal plasma that completes a secondary circuit of the transformer and dissociates the gas, the dissociated gas flowing into the process chamber.

2. The apparatus of claim 1 wherein the plasma extends into the process chamber.

3. The apparatus of claim 1 wherein the plasma extends to the sample holder.

4. The apparatus of claim 1 wherein a portion of the magnetic core is positioned within the process chamber.

5. The apparatus of claim 1 wherein the plasma chamber comprises a portion of a top surface of the process chamber.

6. The apparatus of claim 1 wherein the plasma chamber comprises a removable lid that is a portion of the process chamber.

7. The apparatus of claim 1 wherein the one or more switching semiconductor devices comprises one or more switching transistors.

8. The apparatus of claim 1 wherein the output of the one or more switching semiconductor devices is directly coupled to the primary winding.

9. The apparatus of claim 1 wherein the plasma chamber comprises an electrically conductive material and at least one dielectric region that forms an electrical discontinuity in the plasma chamber.

10. The apparatus of claim 9 wherein the electrically conductive material comprises aluminum.

11. The apparatus of claim 10 wherein the aluminum is anodized.

12. The apparatus of claim 1 wherein the plasma chamber comprises a dielectric material.

13. The apparatus of claim 1 further comprising an electrode positioned in the plasma chamber that generates free charges that assist the ignition of the plasma in the plasma chamber.

14. The apparatus of claim 1 further comprising an electrode capacitively coupled to the plasma chamber that generates free charges that assist the ignition of the plasma in the plasma chamber.

15. The apparatus of claim 1 further comprising an ultraviolet light source optically coupled to the plasma chamber that generates free charges that assist the ignition of the plasma in the plasma chamber.

16. The apparatus of claim 1 further comprising a circuit for measuring electrical parameters associated with the primary winding and the plasma, the electrical parameters including one or more of a current driving the primary winding, a voltage across the primary winding, an average power in the primary winding, and a peak power in the primary winding.

17. The apparatus of claim 16 further comprising a power control circuit having an input coupled to an output of the circuit for measuring electrical parameters associated with the primary winding and the plasma and an output coupled to the solid state AC switching power supply, the power control circuit controlling voltage and current supplied to the primary winding.

18. The apparatus of claim 1 further comprising a power supply that is electrically coupled to the sample holder, the power supply biasing the material to be processed relative to a potential of the plasma.

19. The apparatus of claim 1 wherein the material to be processed comprises at least one of a solid, powder, and a gas.

20. The apparatus of claim 1 wherein the material to be processed comprises a semiconductor material.

21. A material processing apparatus comprising:

a. a process chamber;

b. a plasma chamber comprising a portion of an outer surface of the process chamber, the plasma chamber containing a gas;

c. a transformer having a magnetic core surrounding a portion of the plasma chamber and a primary winding; and

d. a solid state AC switching power supply comprising one or more switching semiconductor devices coupled to a voltage supply and having an output coupled to the primary winding,

the solid state AC switching power supply driving an AC current in the primary winding, the current inducing an AC potential inside the plasma chamber that directly forms a toroidal plasma that completes a secondary circuit of the

transformer and dissociates the gas, the dissociated gas flowing into the process chamber, thereby cleaning the process chamber.

22. The apparatus of claim 21 wherein a portion of the magnetic core is positioned within the process chamber.

23. The apparatus of claim 21 wherein the plasma extends into the process chamber.

24. The apparatus of claim 21 wherein the plasma chamber comprises an electrically conductive material and at least one dielectric region that forms an electrical discontinuity in the chamber.

25. The apparatus of claim 21 further comprising an electrode positioned in the chamber that generates free charges that assist the ignition of the plasma in the plasma chamber.

26. The apparatus of claim 21 further comprising an electrode capacitively coupled to the chamber that generates free charges that assist the ignition of the plasma in the plasma chamber.

27. The apparatus of claim 21 further comprising an ultraviolet light source optically coupled to the chamber that generates free charges that assist the ignition of the plasma in the plasma chamber.

28. The apparatus of claim 21 further comprising a circuit for measuring electrical parameters associated with the primary winding and the plasma, the electrical parameters including one or more of a current driving the primary winding, a voltage across the primary winding, an average power in the primary winding, and a peak power in the primary winding.

29. The apparatus of claim 28 further comprising a power control circuit having an input coupled to an output of the circuit for measuring electrical parameters associated with the primary winding and the plasma and an output coupled to the solid state AC switching power supply, the power control circuit controlling voltage and current supplied to the primary winding.

30. A method for delivering reactive species to a process chamber, the method comprising:

a. confining a gas in a plasma chamber comprising a portion of the outer surface of the process chamber;

b. generating a current with a solid state AC switching power supply;

c. inducing an AC potential inside the plasma chamber by passing the current though a primary winding of a transformer having a magnetic core surrounding a portion of the chamber, the induced AC potential directly forming a toroidal plasma that completes a secondary circuit of the transformer and dissociates the gas; and

d. directing the dissociated gas into the process chamber.

31. The method of claim 30 further comprising forming a plasma chamber comprising a portion of an outer surface of the process chamber.

32. The method of claim 30 further comprising directing the dissociated gas to material to be processed.

33. The method of claim 30 further comprising extending the plasma into the process chamber.

34. The method of claim 30 further comprising providing an initial ionization event in the plasma chamber.

35. The method of claim 34 wherein the providing of the initial ionization event in the chamber comprises applying a voltage pulse to the primary winding.

36. The method of claim 34 wherein the providing of the initial ionization event in the chamber comprises exposing the chamber to ultraviolet light.

37. The method of claim 30 wherein the gas comprises at least one of a noble gas and a reactive gas.

38. The method of claim 30 further comprising measuring electrical parameters including at least one of the current passing though the primary winding, a voltage across the primary winding, an average power in the primary winding, and a peak power in the primary winding.

39. The method of claim 30 further comprising the step of adjusting a magnitude of the current generated by the solid state AC switching power supply from the measured electrical parameters and from predetermined operating conditions.

40. The method of claim 30 wherein a pressure in the plasma chamber is substantially between 1 mtorr and 100 torr.

41. The method of claim 30 wherein an electric field of the plasma is substantially between 1-100 V/cm.

42. A method for cleaning a process chamber, the method comprising:

a. confining a gas in a plasma chamber comprising a portion of the outer surface of the process chamber;

b. generating a current with a solid state AC switching power supply;

c. inducing an AC potential inside the plasma chamber by passing the current though a primary winding of a transformer having a magnetic core surrounding a portion of the chamber, the induced AC potential directly forming a toroidal plasma that completes a secondary circuit of the transformer and dissociates the gas; and

d. directing the dissociated gas into the process chamber, thereby cleaning the process chamber.

43. The method of claim 42 wherein the reactive gas comprises at least one of an oxygen or a fluorine containing gas.

44. An apparatus for dissociating gases, the apparatus comprising:

a. a process chamber;

b. a plasma chamber comprising a portion of an outer surface of the process chamber, the plasma chamber comprising an electrically conductive material and at least one dielectric region that forms an electrical discontinuity in the plasma chamber; the plasma chamber containing a gas;

c. a transformer having a magnetic core surrounding a portion of the plasma chamber and a primary winding; and

d. a solid state AC switching power supply comprising one or more switching semiconductor devices coupled to a voltage supply and having an output coupled to the primary winding,

the solid state AC switching power supply driving an AC current in the primary winding, the current inducing an AC potential inside the chamber that directly forms a toroidal plasma that completes a secondary circuit of the transformer and dissociates the gas, the dissociated gas flowing into the process chamber.

45. The apparatus of claim 44 wherein the chamber comprises aluminum.

46. The apparatus of claim 44 wherein the aluminum is anodized.

47. The apparatus of claim 44 wherein the chamber comprises cooling channels for passing a fluid that controls the temperature of the chamber.

48. A method for delivering reactive species to a process chamber, the method comprising:

a. forming a plasma chamber comprising a portion of an outer surface of a process chamber;

b. confining a gas in the plasma chamber;

c. generating a current with a solid state AC switching power supply;

d. inducing an AC potential inside the plasma chamber by passing the current though a primary winding of a transformer having a magnetic core surrounding a portion of the chamber, the induced AC potential directly forming a toroidal plasma that completes a secondary circuit of the transformer and dissociates the gas; and

e. directing the dissociated gas into the process chamber.

49. A method for processing substrates, the method comprising:

a. forming a plasma chamber comprising a portion of an outer surface of a process chamber;

b. confining a gas in the plasma chamber;

c. generating a current with a solid state AC switching power supply;

d. inducing an AC potential inside the plasma chamber by passing the current though a primary winding of a transformer having a magnetic core surrounding a portion of the chamber, the induced AC potential directly forming a toroidal plasma that completes a secondary circuit of the transformer and dissociates the gas; and

e. directing the dissociated gas onto substrates positioned in the process chamber, thereby processing the substrates.

50. The method of claim 50 wherein the method comprises etching the substrates.

51. The method of claim 50 wherein the method comprises depositing a dielectric material onto the substrates.